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Telomere Length and Air Pollution: Observations in Women Who Use Biomass Cookstoves

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Telomeres, the DNA sequences that cap and protect chromosomes, lose base pairs with each new cell division.[1] As telomeres shorten over time, chromosomes slowly degrade in one of several processes that contribute to cellular aging.[2] Inflammation and oxidative stress—which are both triggered by air pollution—accelerate telomere shortening.[3,4] Therefore, air pollution may speed cellular aging as well as the onset of chronic diseases that come with it. A study published recently in *Environmental Health Perspectives* has now provided evidence that indoor air pollution—in this case, associated with biomass cookstoves—may cause telomere shortening.[5]

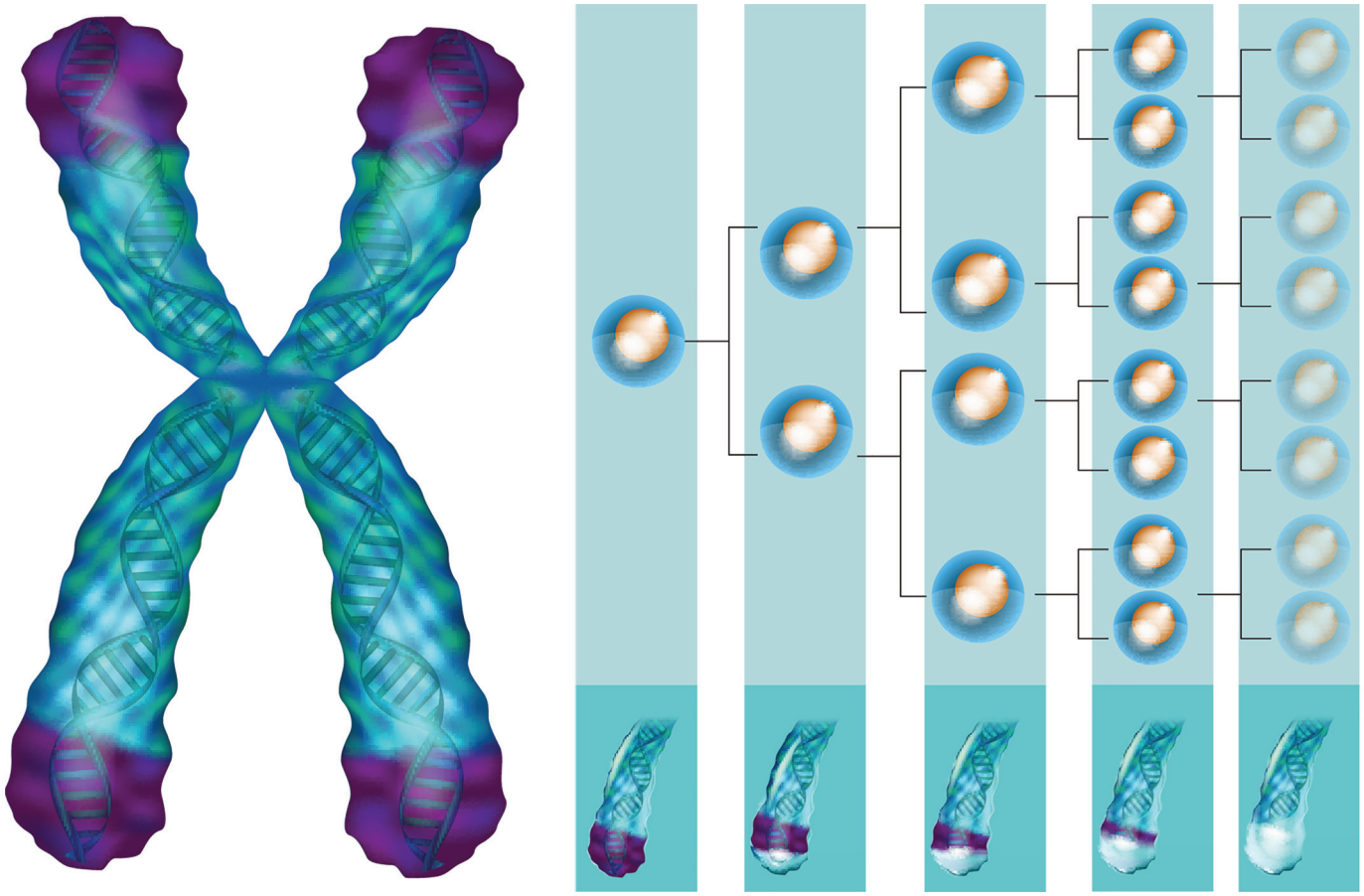
"Our study is the first to show this association with household air pollution," says Jill Baumgartner, an environmental epidemiologist at McGill University in Montreal, Canada, who led the research. "It's significant given that biomass stove emissions affect nearly half the world's population,[6] and telomere shortening is potentially a very important indicator for long-term health."

Baumgartner and her team performed the study in 12 rural villages in a mountainous rural area in Sichuan, China, which had been devastated by an earthquake in 2008. As part of a government-sponsored recovery program, local villagers had been supplied with indoor stoves that burn biomass. Residents burned mostly wood and crop residues in these stoves.

Baumgartner and her colleagues outfitted 137 local women (28–88 years of age) with wearable monitors to measure their personal exposures to black carbon and fine particulate matter ($PM_{2.5}$). Sooty black carbon derives mainly from incomplete combustion, whereas $PM_{2.5}$ has many potential combustion and noncombustion sources, including dust.

The research was limited to women because they are the primary cooks in this region and thus disproportionately exposed to stove emissions. This also prevented confounding from tobacco smoking, which in this area is a habit primarily among men.

Air monitoring took place during three sampling campaigns lasting 48 hours each, two in winter and one in summer. The women provided cheek swabs for DNA analysis. They also filled out questionnaires on their diets, alcohol use, tobacco smoke exposure, and several other potential confounders that also are associated with shortening of telomeres.



Chromosomes naturally lose a small portion of telomeric DNA with each cell division. Once telomeres reach a minimum size, apoptosis commences, and the cell dies. Although this is a natural process, certain environmental exposures and lifestyle factors can hasten telomere shortening, increasing an individual's risk for age-related conditions such as coronary heart disease, cancer, osteoporosis, and diabetes. Image: © Sakurra/Shutterstock.

The monitoring showed that air pollution exposure levels varied widely: 13–1,136 $\mu g/m^3$ (mean: 154 $\mu g/m^3$) for $PM_{2.5}$ and 0.1–34.0 $\mu g/m^3$ (mean: 3.6 $\mu g/m^3$) for black carbon. Baumgartner says the highest exposures occurred episodically while the women were cooking. "After that, pollution concentrations would decrease to the levels detected in outdoor air, which are more stable but can still exceed WHO [World Health Organization] targets," she says. The WHO has set an interim air quality target of 35 $\mu g/m^3$ (annual average) for $PM_{2.5}$. There currently is no WHO target or guideline for black carbon.

The investigators estimated that each interquartile increase in both $PM_{2.5}$ and black carbon measures was associated with a shorter relative telomere length. Associations were generally consistent between younger and older women, women with higher and lower body mass index and waist circumference, and women with and without secondhand tobacco smoke exposure.

The new findings "confirm what we've seen in other studies[7] showing that air pollution induces this particular response," says Michael Brauer, a professor of occupational and environmental health at the University of British Columbia in Vancouver, Canada, who was not involved in the investigation. However, Brauer adds that further research is still needed to assess the clinical significance of telomere shortening on long-term health outcomes.

Maggie Clark, an assistant professor of epidemiology at Colorado State University in Fort Collins, who likewise was not involved in the study, calls the research an important contribution. "We often have limited resources to follow populations over time, and that makes predictive biomarkers attractive as surrogates for long-term health impacts," she says.

Telomere shortening is potentially a good option for such a biomarker Clark says: "It is noninvasive—you just need a swab from the cheek—and it could potentially provide information about age-related conditions we think contribute most to the global burden of disease attributed to household air pollution." The next step, she says, should be to determine if interventions that reduce household air exposures slow the rate at which telomeres shorten over time.

Charles W. Schmidt, MS, an award-winning science writer from Portland, Maine, writes for *Scientific American*, *Science*, *Undark*, various *Nature* publications, and many other magazines, research journals, and websites.

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